Astro Techniques II

Assignment-2; Given - 27 Apr, 2016; Due on - 22 May, 2016

1. Assume that solar disc has a diameter of 30 arcmin and a constant temperature of 5800 K.
   (a) Derive the flux density of the Sun at 30 GHz.
   (b) What would be measured antenna temperatures when observing the Sun, if it was observed by single dishes of diamter 30m, 3m and 0.3m, respectively? Assume 100% aperture efficiency.
2. Derive the expression for the sensitivity of a Stokes I synthesis image.
3. All real life measurements are averaged over finite bandwidths and time intervals. If the visbilities change significantly over the frequency and/or time span over which the averaging is done, it leads to *smearing* in the image plane. Describe the impact of time and frequency smearing on the images. List all the assumptions which you make.
4. All electromagnetic radiation from cosmic source must pass through the Earth's atmosphere on its way to the terrestrial telescopes. Assume the atmosphere to be a single flat layer of optical depth (τ) 0.1 at a temperature of 250 K.
   (a) What is excess noise contribution from the atmosphere, and by how much does it reduce the intensity of the celestial sources?
   (b) If τ were increased to 0.5, what would be the change in the above numbers?
   (c) If τ is related to the optical depth towards zenith (τ_z) by $\tau = \tau_z/sin(el)$, where el is the elevation angle. Determine the increase in τ between elevation of 30° and 20°.
   (d) Compute antenna temperature due to the CMBR when the telescope is pointed to an elevation of 30°. Assume a circular beam of 20° HPBW if you need to.
5. Two antennas of diameter 20 m are available to you with a feed and signal chain set up to observe at 1 GHz. This instrument is set up as a two element interferometer with a East-West baseline of 100 m. It is used to observe a one dimensional double radio source which can be modeled as described below. The two emission centers are separated by 1.5' along the East-West direction, each has a FWHM size of 50" and a uniform flux density distribution. The integrated flux density of each of the lobes is 50 Jy. Work in one dimension and list any simplifying assumptions which you make.
   (a) What is the FWHM of each of the dishes?
   (b) What is the antenna temperature (T_B) due to the double radio source? Assume an antenna efficiency of 0.7.
   (c) What will be the output of the interferometer as it tracks the source from rise to set. Express your answer in units of T_B measured by an individual dish.